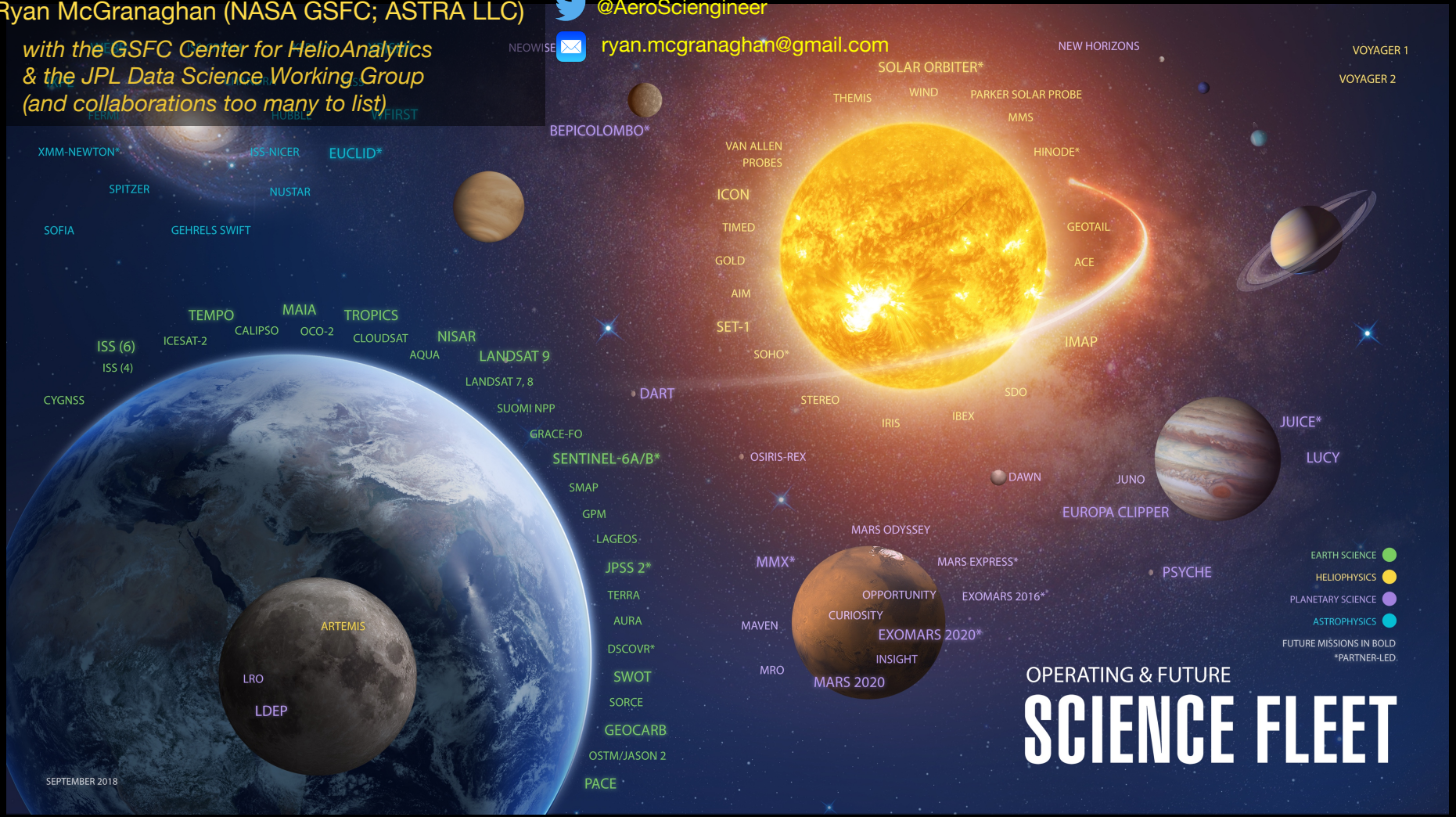
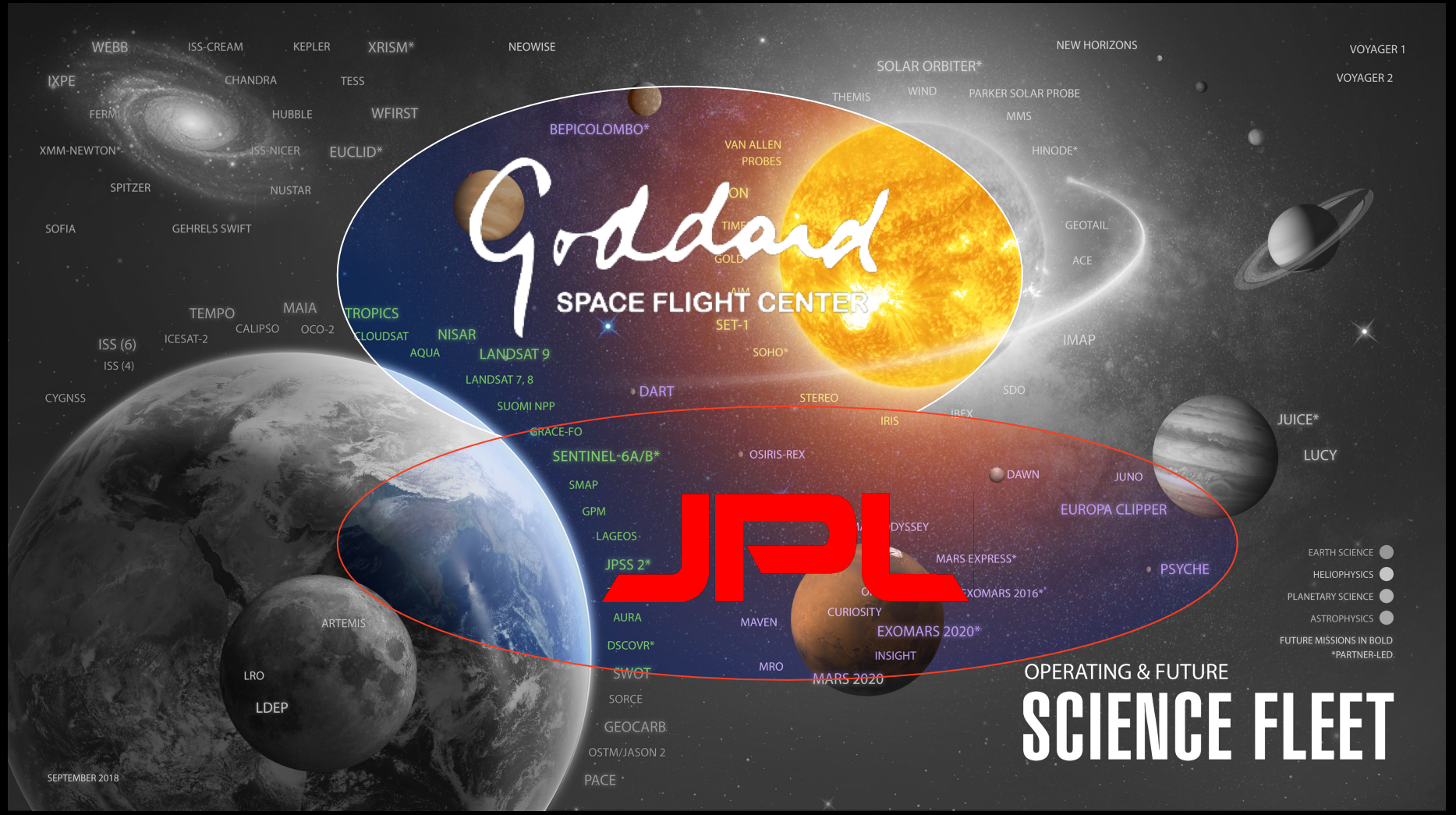
Ryan McGranaghan (NASA GSFC; ASTRA LLC)
@AeroSciengineer
ryan.mcgranaghan@gmail.com
with the GSFC Center for HelioAnalytics & the JPL Data Science Working Group (and collaborations too many to list)

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TESS
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PLANETARY SCIENCE
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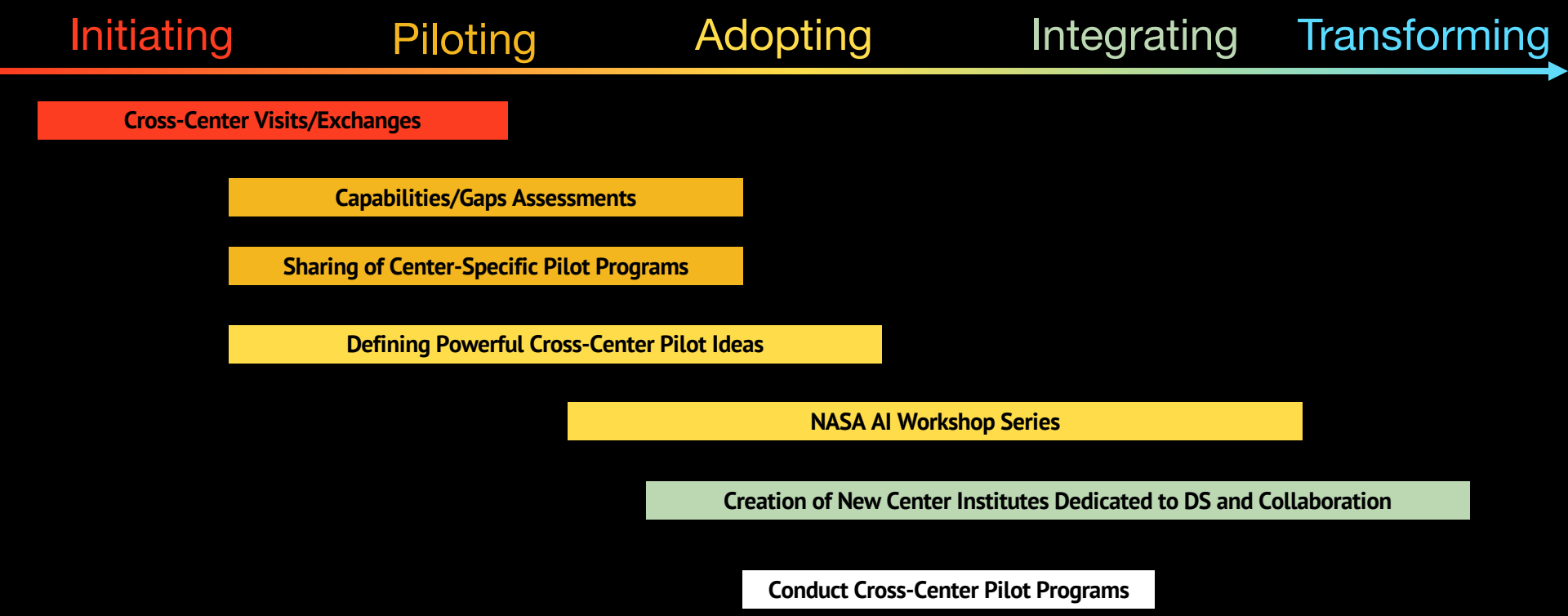
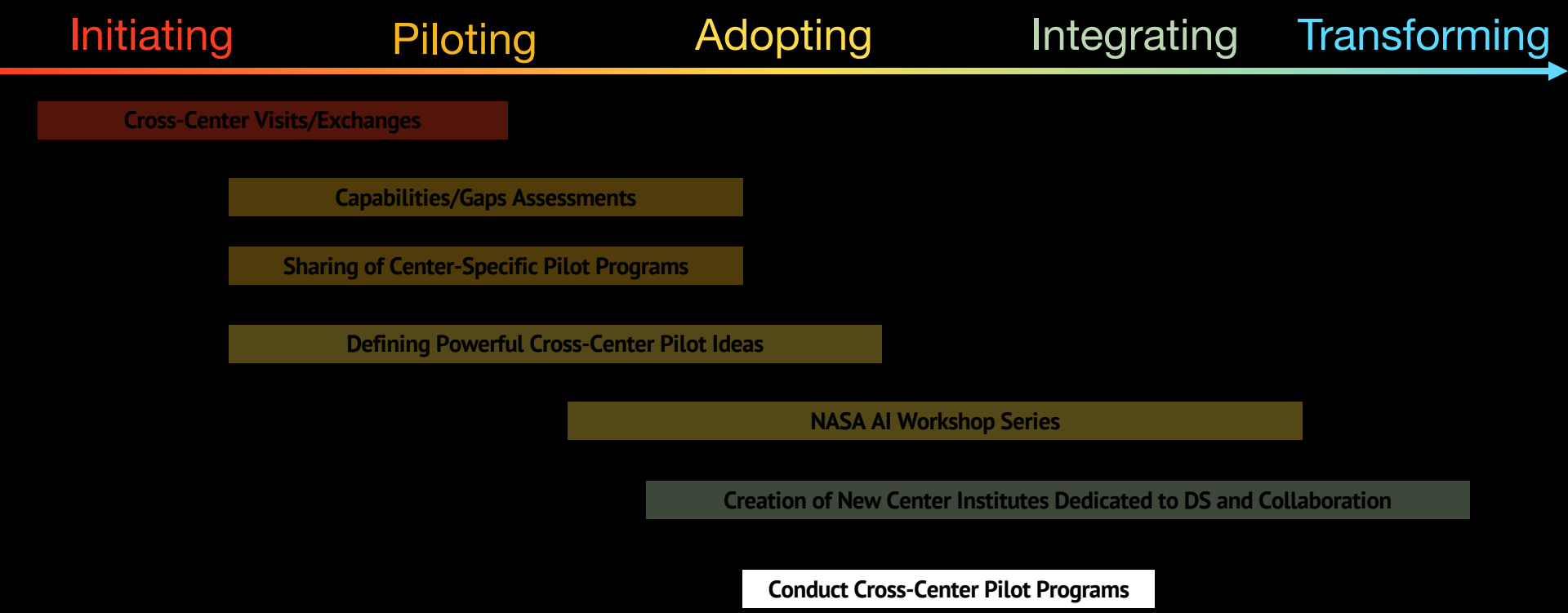

Initiating
Piloting
Adopting
Integrating
Transforming
Cross-Center Visits/Exchanges
Capabilities/Gaps Assessments
Sharing of Center-Specific Pilot Programs
Defining Powerful Cross-Center Pilot Ideas
NASA AI Workshop Series
Creation of New Center Institutes Dedicated to DS and Collaboration
Conduct Cross-Center Pilot Programs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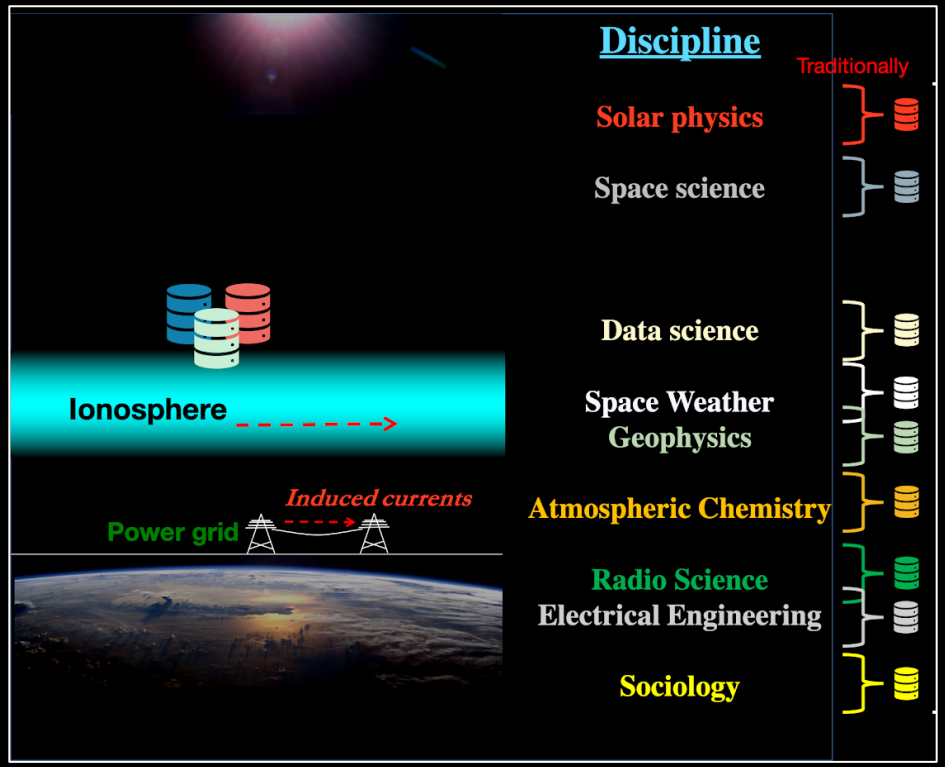
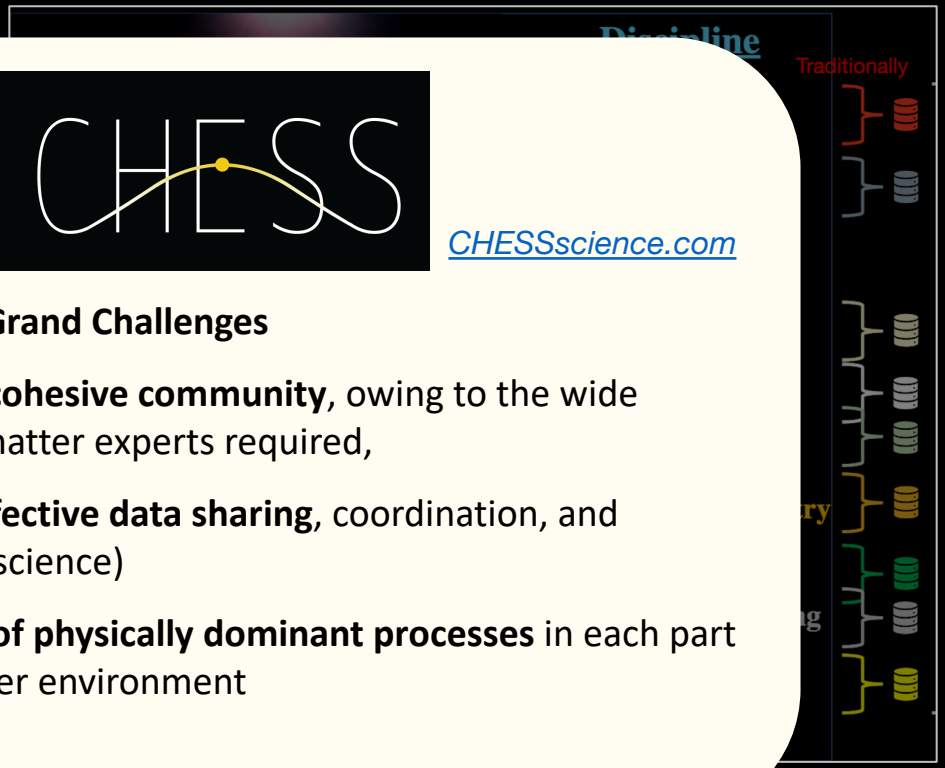
NASA AI Workshop Series

Creation of New Center Institutes Dedicated to DS and Collaboration


NSF CONVERGENCE
ACCELERATOR



GICs = Geomagnetically Induced Currents



CHESS

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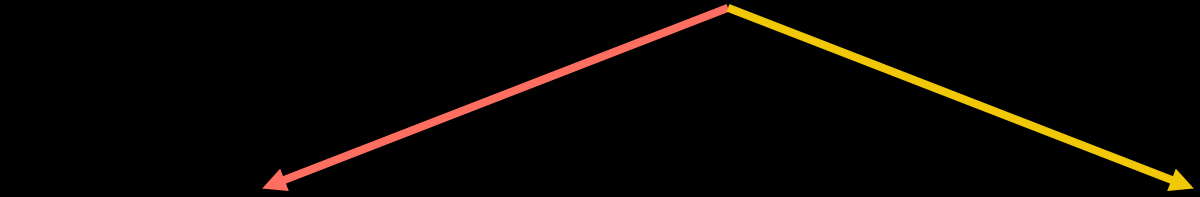
Respond to three Grand Challenges

(1) the **lack of a cohesive community**, owing to the wide variety of subject matter experts required,

(2) the **lack of effective data sharing**, coordination, and analysis (e.g., data science)

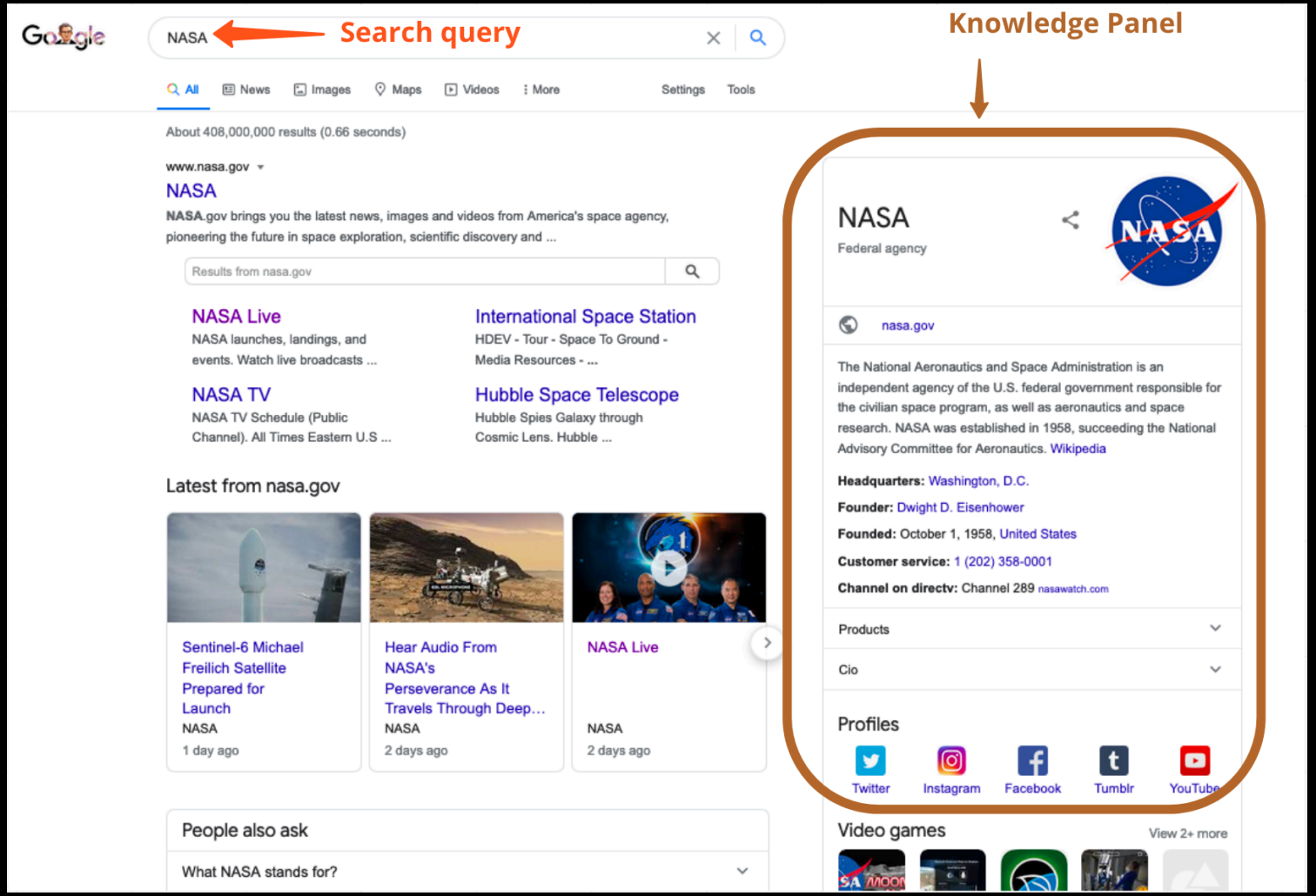
(3) the **diversity of physically dominant processes** in each part of the space weather environment

Knowledge Networks



Diverse data integration system

Applications layered on top of the data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The National Aeronautics and Space Administration is an independent agency of the U.S. federal government responsible for the civilian space program, as well as aeronautics and space research. NASA was established in 1958, succeeding the National Advisory Committee for Aeronautics. Wikipedia
Headquarters: Washington, D.C.
Founder: Dwight D. Eisenhower
Founded: October 1, 1958, United States
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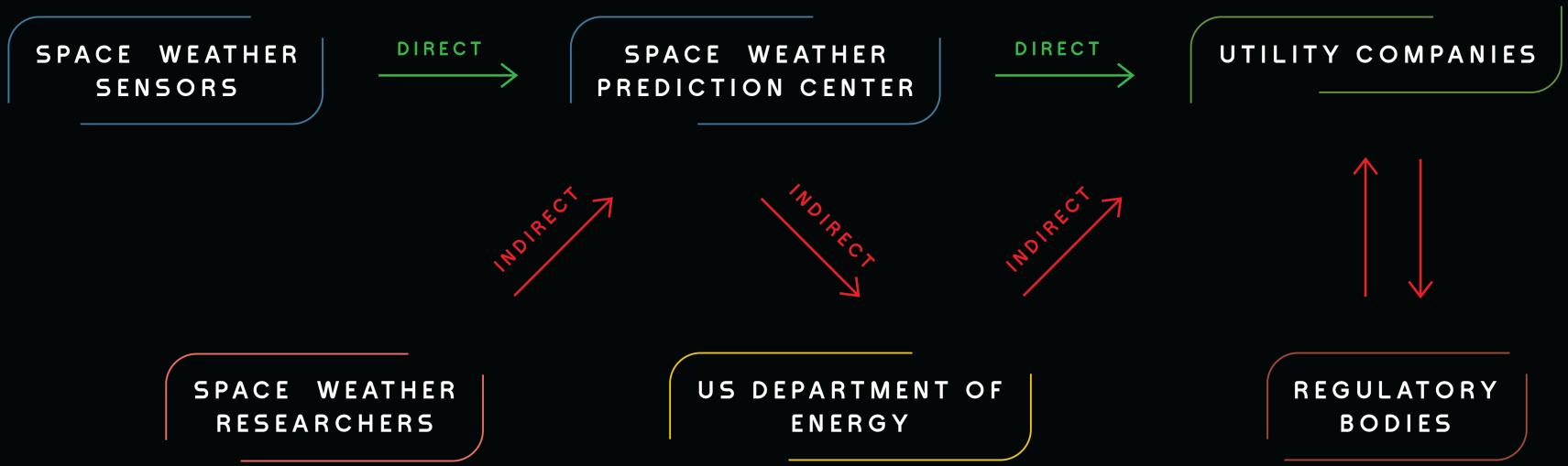
SPACE WEATHER SENSORS
DIRECT
SPACE WEATHER PREDICTION CENTER
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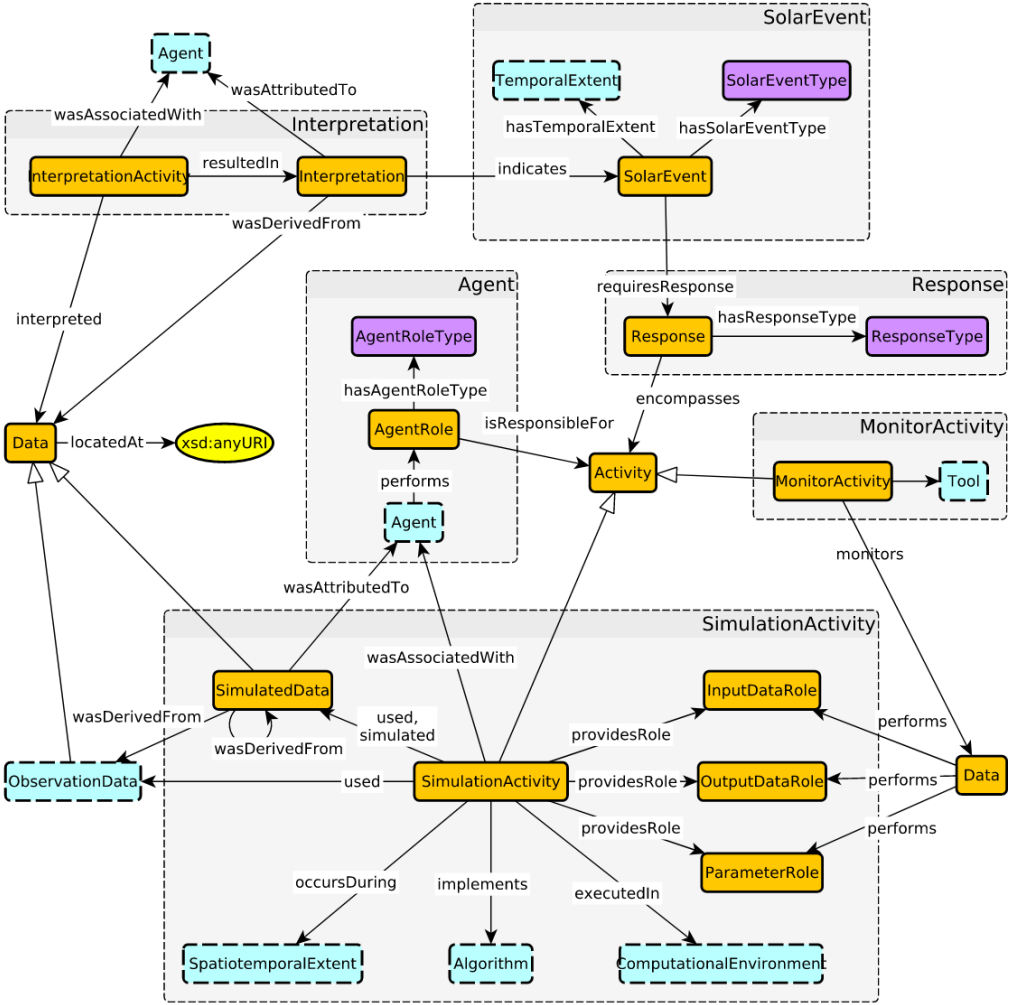
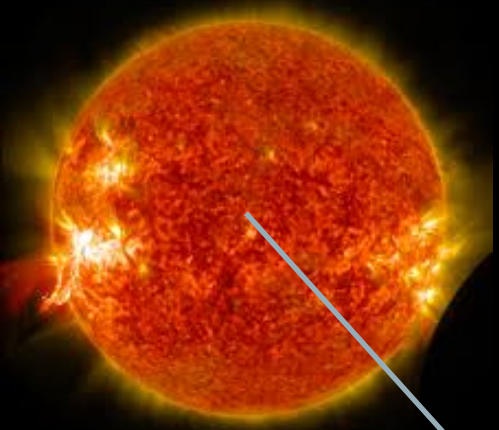
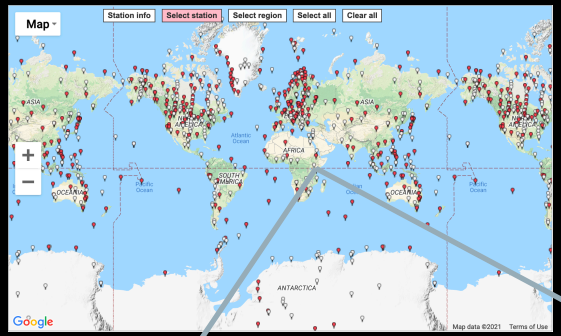
INDIRECT
INDIRECT
INDIRECT
SPACE WEATHER RESEARCHERS
US DEPARTMENT OF ENERGY
REGULATORY BODIES

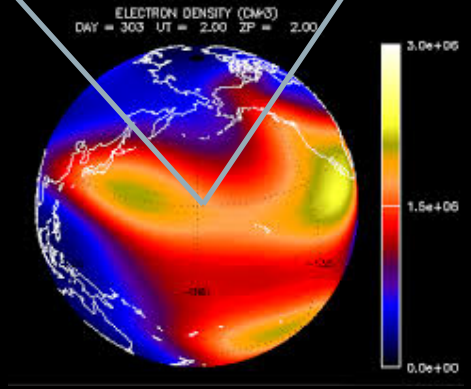


Full paper on the ontology: https://arxiv.org/abs/2009.12285

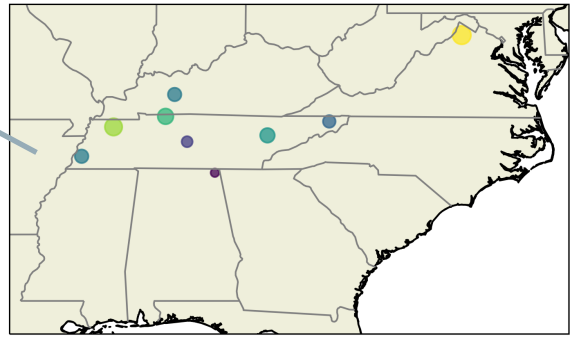
Highlight #1: Link GIC data to simulation data to remove quiet-time variation and create ML database to study space weather disturbed periods and predict GICs







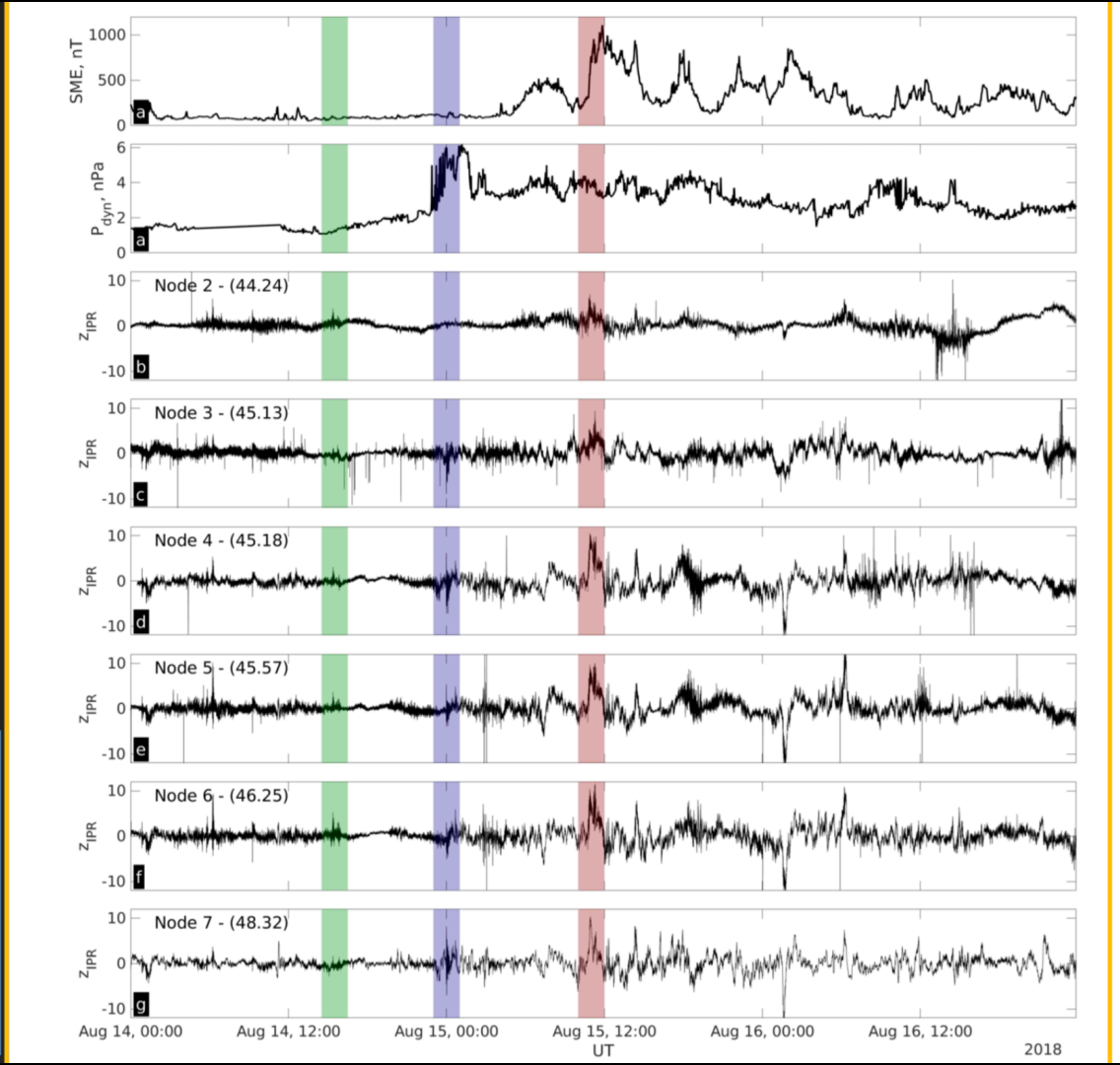
Tennessee Valley Authority (TVA)
Power Grid GIC monitors



Full paper:
https://tinyurl.com/Kellerman2020

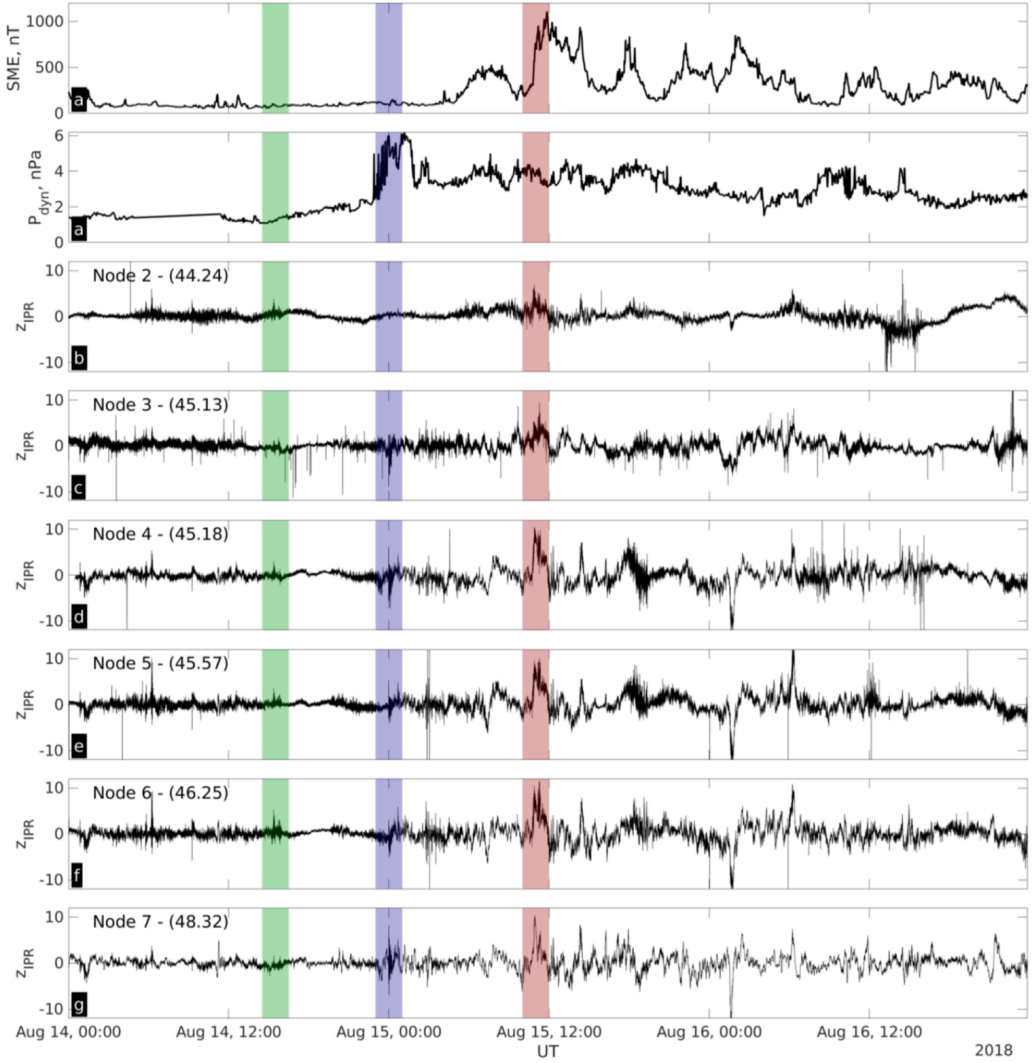
Reduced data wrangling with Knowledge Network approach: Reduce time to discovery

Used link to Global Circulation Models to discover and systematically remove quiet-time variation
→ Z-Score = Time series quiet variations removed



Reduced data wrangling with Knowledge Network approach: Reduce time to discovery

GIC time series aligned with solar wind and space weather activity time series



GIC significance

Three events during a period of quiet to moderate geomagnetic activity

Event 1 – Quiet

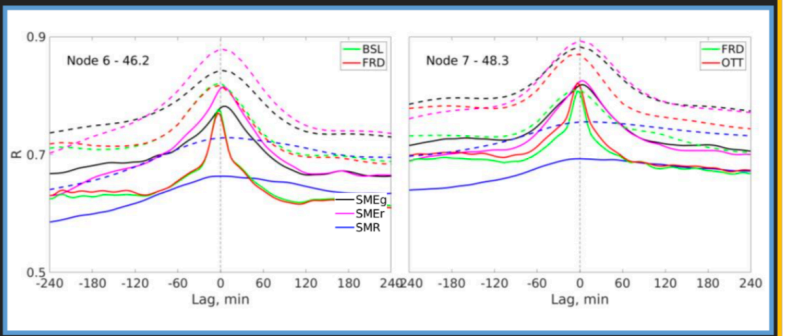
Event 2 – Elevated dynamic pressure, low SME

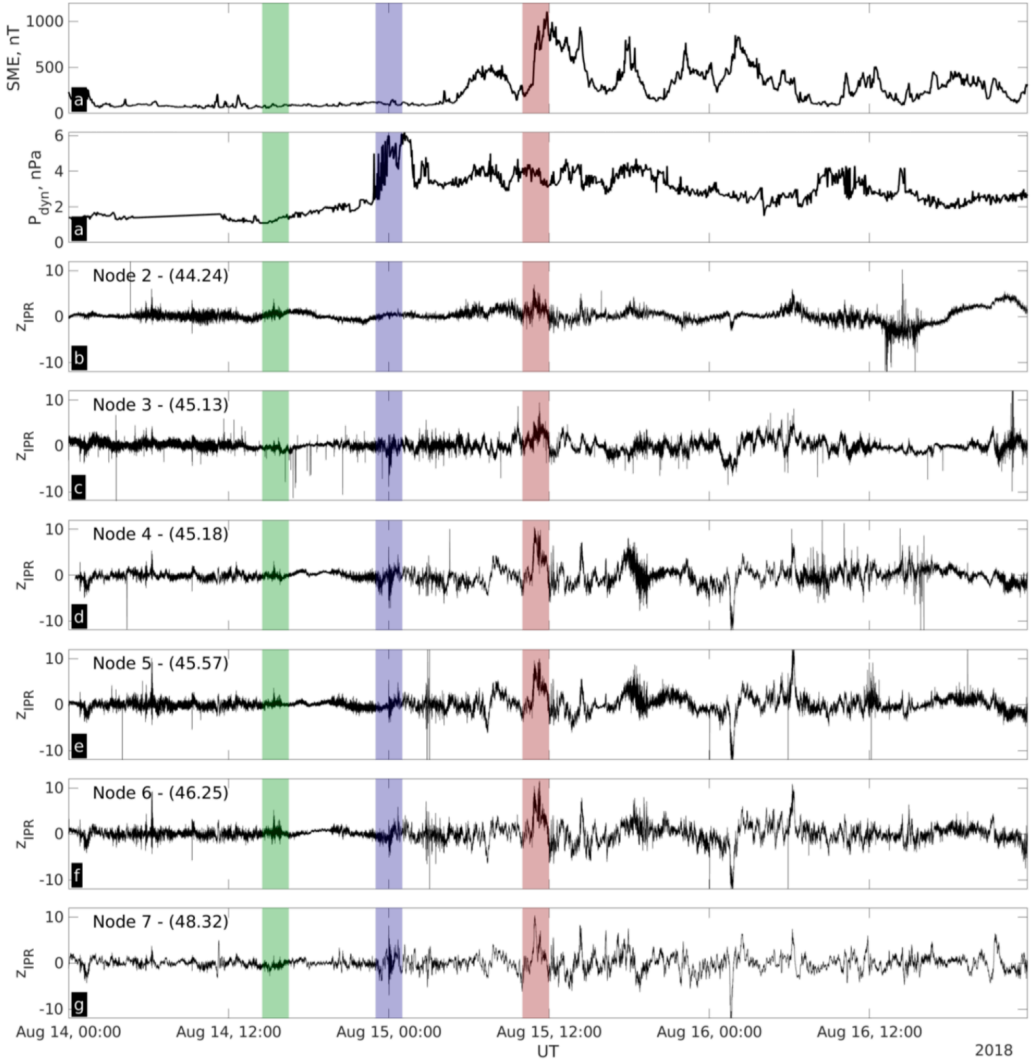
Event 3 – Elevated solar wind velocity, high SME

The observed GIC in event 3 is due to elevated geomagnetic activity, as defined by the SME

Cross-correlation analysis indicates a near-instantaneous response to geomagnetic activity

Volatility in GIC and geomagnetic activity

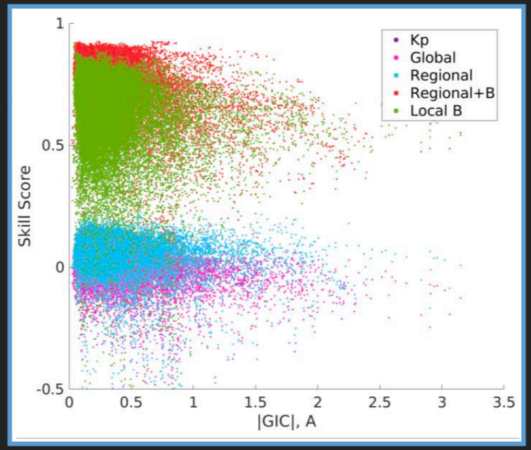


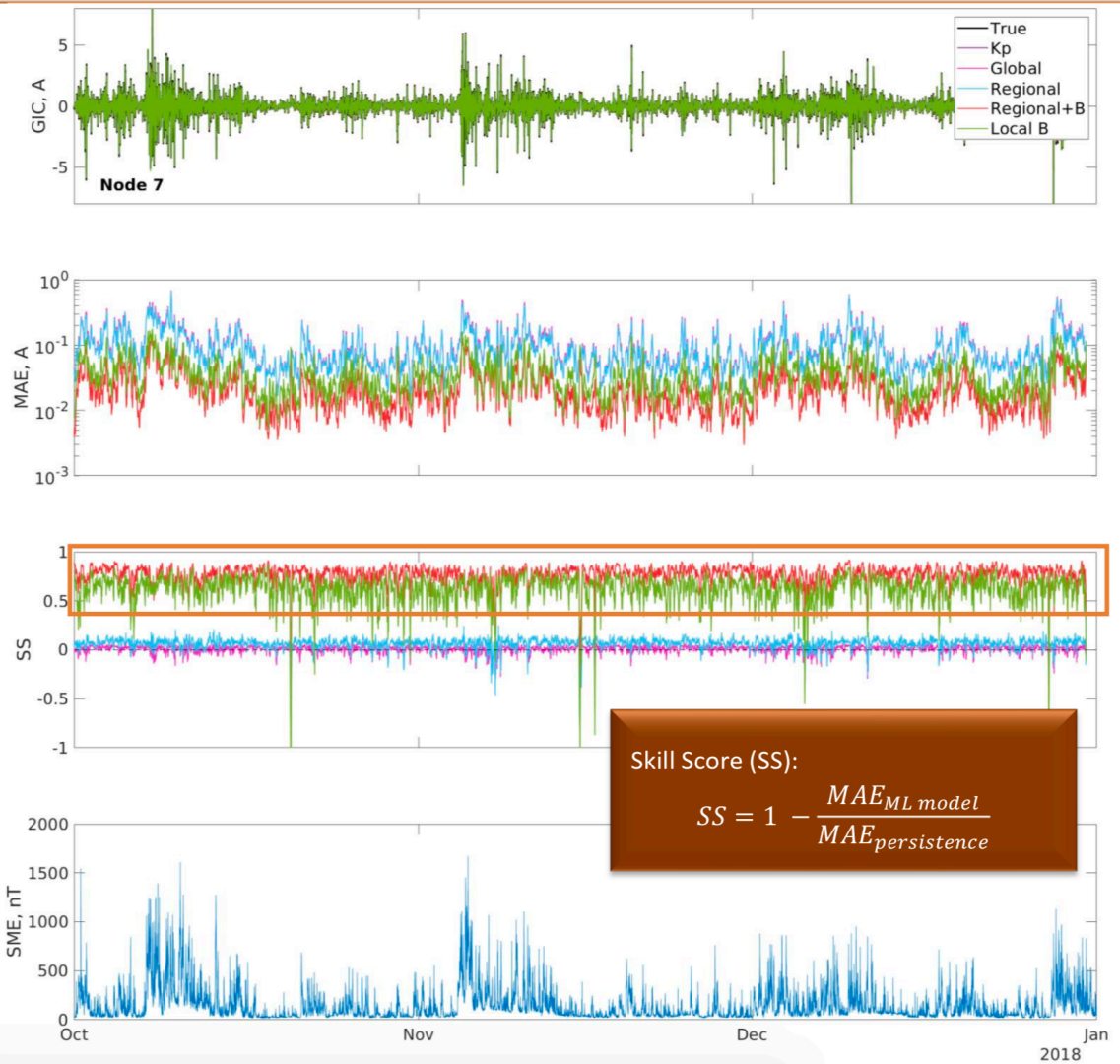


GIC forecasting

SOCNN – 1-minute forecast.

The most skillful models are those that include nearby magnetic field perturbations



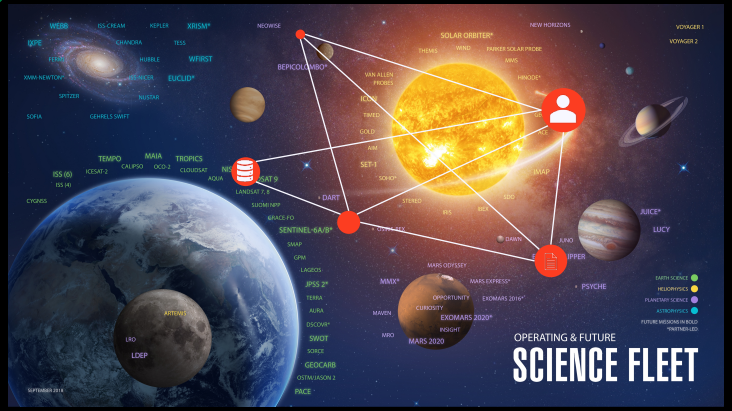


Skill Score (SS):

$$SS = 1 - \frac{MAE_{ML\ model}}{MAE_{persistence}}$$

A proposal: A model for crossing boundaries with data science

1 Knowledge graph formulation



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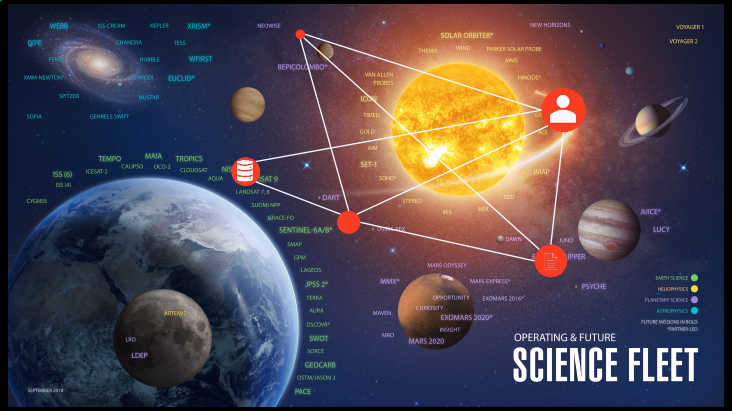
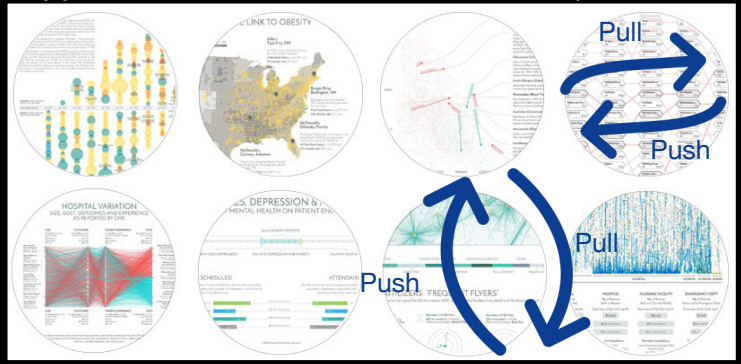


2 Ecosystem of ‘boundary navigating objects’ (e.g., Jupyter Notebooks based on use cases)



docker

A proposal: A model for crossing boundaries with data science

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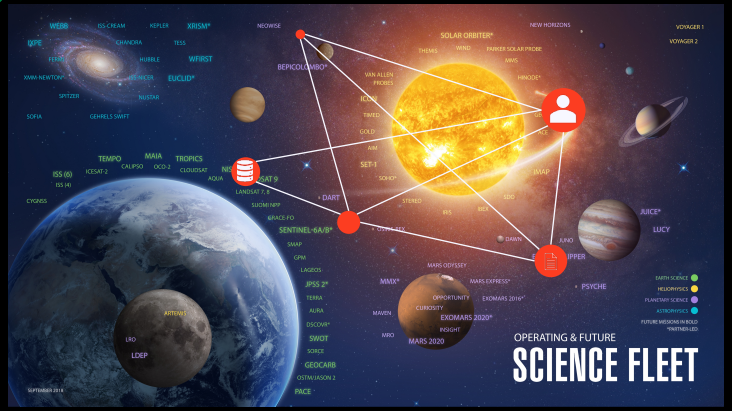

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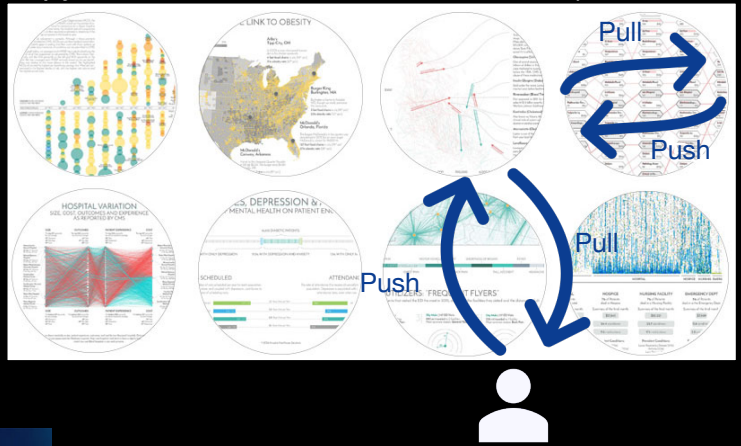

3 ‘Neo-ML’

Backup

Resources

- HelioAnalytics – Goddard Space Flight Initiative to "*harness advanced statistics, informatics and computer science methods to achieve science*"
- Thought-leaders:
  - Kirk Borne and on Twitter
  - Joi Ito
  - Cesar Hidalgo
  - Andrew Ng
  - Barbara Thompson
  - Naval Ravikant
  - Hilary Mason
  - *Expand your horizons with the papers that you read, the fields to which you pay attention, and the thinkers that you choose to learn from
- Compilations of resources
  - Non-traditional funding resources
  - Data science tools and resources
  - Data Science Success Stories from Science and Engineering
- Being 'antidisciplinary'/Convergent
  - MIT Media Lab
  - Fall AGU Town Hall 2018: "Data Science and a New Scientific Frontier in Space Science"
  - Fall AGU Town Hall 2019: "Antidisciplinary: Science and engineering in the digital age"
- Podcasts
  - Origins
  - Microsoft Research Podcast
  - Grey Mirror Podcast
  - Voices from DARPA
  - Artificial Intelligence Podcast
  - Data Skeptic

Resources (cont'd)

- Camporeale et al., [2019]
- AGU Earth and Space Science Informatics (ESSI)
- National Research Council "Enhancing the Effectiveness of Team Science"
- Meetups, hackathons, and unconferences
- Open source communities (e.g., Open Source Initiative)
- Citizen Science
- Many resources to discover based on your own passions and search!